Engine performance and emission analysis by using biodiesel and its blends

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Abstract— Biomass derived from vegetables oils are quite promising alternative fuels for agricultural diesel engines. The performance of vegetable oils can be improved by modifying them through the transestrification process. The fuel properties of biodiesel such as kinematic viscosity, calorific value, flash point, carbon residues and specific gravity were found. Results indicated that B20 has closer performance to diesel and highest brake thermal efficiency was obtained for blend B20 with 31.86 mainly due to its high viscosity compared to diesel. For Jatropha biodiesel and its blended fuels, the exhaust gas temperature increased with increase in power and amount of biodiesel. But, diesel blends showed reasonable efficiency, lower smoke, CO_2, CO.

Key words: Jatropha oil, bio-fuels, transestrification, exhaust gas.

I. INTRODUCTION

Majority of the worlds energy needs are supplied through petrochemical sources, coal and natural gases. With the exception of hydroelectricity and nuclear energy, all of these sources are finite and at current usages rates will be consumed shortly. Internal combustion (I.C.) engines particularly of the compression ignition (C.I.) type using diesel fuel play an important role in industrial economy of a developing country. An alternative fuel must be technically feasible and economically competitive. One possible alternative to fossil fuel is the use oils of plant origin like vegetable oils and tree borne oil seeds. This alternative diesel fuel can be termed as biodiesel.

Biodiesel, which is considered as a possible substitute of conventional diesel fuel is commonly composed of fatty acid that can be prepared from triglycerides in vegetable oil by transestrification with methnol. The main sources for biodiesel in India can be non-edible oils obtained from plant species such as Jatropha curcas, Pongamia Pinnata etc. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend or can be used in its pure form. The use of biodiesel in conventional diesel engines results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matters. Biodiesel is considered clean fuel since it has no sulpher and has about 10 % built in oxygen, which helps it to burn fully. Its higher cetane number improves the ignition quality even when blended in the petroleum diesel. Biodiesel offers safety benefits over petroleum diesel because it is much less combustible, with flash point greater than 150^0C, compared to 77^0C for petroleum diesel. Experiments were conduced to find out the optimum compression ratio for different blends of Jatropha oil with diesel fuel in C.I. engine. It will seen analytically that how the different blends ratios of biodiesel used during the experiment can affect the power output, efficiency and exhaust emissions from engine.

II. MATERIAL AND METHODS

In this work the methyl ester of Jatropha oil was investigated for its performance as a diesel engine fuel.

The various physical and chemical properties of Jatropha crude oil and Jatropha biodiesel after transestrification are presented in Table 1

Sr. no.	Property	Diesel	B20	B50	B75	B100
1	Density (gm/cc)	0.84	0.85	0.870	0.875	0.88
2	Flash point (^{0}C)	80	124	146	171	179
3	Fire point (^{0}C)	110	133	169	183	191
4	Viscosity (cst)	2.5	3.4	4.6	5.7	6.7
5	Cetane No.	50	51	52	53	54
6	Carbon residue (%)	1.10	1.32	1.50	1.6	1.7
7	Ash content (%)	0.01	0.01	0.01	0.01	0.01
8	Calorific value (MJ/Kg)	42.4	42.4	40.68	39.2	37.78

Table. 1 : Properties of diesel and Jatropha biodiesel

Density, cloud point and pour point of jatropha oil were found higher than diesel. Higher cloud and pour point reflect unsuitability of jatropha oil as diesel fuel in cold climate conditions. Higher viscosity is a major problem in using vegetable oil as fuel for diesel engines. In the present investigation, Viscosity was reduced by transestrification process. Viscosity of jatropha biodiesel is 6.7 CSt at 40^0C. it is observed that viscosity of jatropha oil decreases with increase in temperature and it becomes close to diesel at temperature above 90^0C.

A. Preparation of blends:

The biodiesel blended with diesel by volume as, B10 (10% biodiesel and 90% diesel), B20 (20 % biodiesel and 80 % diesel), B30 (30 % biodiesel and 70 % diesel), B40 (40 % biodiesel, 60 % diesel), B50 (50 % biodiesel, 50 % diesel). Three blends were obtained by mixing diesel and esterified jatropha in the following proportions by volume: 80 % diesel+20 % esterified Jatropha, 25 % diesel+75 % esterified Jatropha, performance parameters like brake thermal efficiency, specific fuel consumption, brake power were determined. Exhaust emissions like CO_2, CO, and smoke have been evaluated. For comparison purpose experiments were also carried out on 100 % esterified Jatropha and diesel fuel.

The engine used for this experimental investigation was a single cylinder 4-stroke naturally aspirated water cooled diesel engine having 5 BHP as rated power at 1500 rpm. The engine was coupled to a brake drum dynamometer to measure the output. Fuel flow rates were timed with calibrated burette. Exhaust gas analysis was performed using a multi gas exhaust analyzer. The pressure crank angle diagram was obtained with help of a piezo electric pressure transducer. A bosch smoke pump attached to the exhaust pipe was used for measuring smoke levels.

Experiments were initially carried out on the engine using diesel as the fuel in order to provide base line data (ISI, 1980). The cooling water temperature at the outlet was maintained at 70^0C. the enging was stabilized before taking all measurements. Subsequently experiments were repeated with methyl ester of jatropha oil for comparison, in all cases, the pressure and crank angle diagram were recorded and processed to get combustion parameters.

III. RESULTS AND DISCUSSION

The performance, combustion parameters and exhaust emissions of the engine with diesel and methyl ester of Jatropha oil are discussed in this chapter.

Sr. No.	Parameters	B20	B50	B75	B100	Diesel
1	Specific fuel consumption (kg/kwhr)	0.270	0.293	0.317	0.355	0.416
2	Brake thermal efficiency (%)	31.86	29.32	27.04	24.84	20.65
3	CO (%)	0.02	0.03	0.03	0.03	0.03
4	CO_2 (%)	6.10	9	8.4	8.8	8.80

Table. 2 : Performance of engine and smoke analysis

A. Specific fuel consumption:

From Table 1 it is seen that the specific fuel consumption at B20 i.e. 0.270 was minimum and it increases as percentage of biodiesel increases. It increases as percentage of biodiesel increases.

B. Brake thermal efficiency (%):

The brake thermal efficiency shows decreasing trend as the percentage of biodiesel increases in diesel. The maximum brake thermal efficiency was observed with B20 (31.86%). Brake thermal efficiency was observed 29.32%, 27.04%, and 24.84% with B50, B75, B100 respectively when compared with brake thermal efficiency of neat diesel 20.65%.

C. CO concentration:

The percentage of CO (in a smoke) emitted with all the blends of biodiesel studied was same 0.03% as compared with neat diesel except at blend B20 (0.02%).

D. CO_2 concentration:

The percentage of CO_2 was higher for the blend B50 and it gives lower value for the blend B20.

IV. CONCLUSION

Methyl esters of Jatropha oil results in a slightly increased thermal efficiency as compared to that of diesel oil. The blend B20 gives less value of specific fuel consumption i.e. 0.270 as well as highest brake thermal efficiency was obtained for blend B20 with 31.86%. The maximum CO_2 concentration obtained for blend B50. It is concluded that the methyl ester of Jatropha oil will be a good alternative fuel for diesel engine for agricultural applications.

REFERENCES

[1] Agrwal A.K., Rajamanoharan K. (2009). Experimental investigations of performance and emissions of Karanja oil and its blends in a single cylinder agricultural diesel engine. *Applied energy*, 86(1):106-112
[2] Kumar M.S., Ramesh A., Nagalingam B. (2003). An experimental comparison of methods to use methanol and Jatropha oil in a compression ignition engine. *Biomass Bioenergy*, 25:309-318
[3] Singh R. K., Padhi S. K. (2009). Characterization of Jatropha oil for preparation of biodiesel . Nat. prod. Radiance, 8(2): 127-132
[4] Sinha S., Misra N.C., (1997). Diesel fuel alternative from vegetable oils. Chem.. Engg. World, 32 (10): 77-80
[5] Pramanik K. (2003). Properties and use of Jatropha oil and diesel blends in compression ignition engine. Renewable Energy, 28 :239-248
[6] Forson F.K., Oduro E.K, Hammond –Donkoh E. (2004). Performance of Jatropha oil blends in a diesel engine. Renewable Energy, 29 (7): 135-145.

